CLAIMS

What is claimed is:

1. A shaker comprising:

a sealed shaker housing

a permanent magnet assembly supported within the housing for vibratory translation along an axis of the permanent magnet assembly, the permanent magnet assembly having a permanent magnet magnetized parallel to the axis, and first and second pole pieces spaced apart along the axis at first and second ends of the permanent magnet;

first and second wire coils spaced adjacent and outward from a periphery of the first and second pole pieces, respectively, and secured to an inner wall of the shaker housing;

the permanent magnet assembly having at least one electrically conductive shorting ring supported on the permanent magnet assembly adjacent at least one of the wire coils;

a first tubular coil fastened to the permanent magnet assembly and flexibly coupled to ports on the shaker housing through which a fluid may be circulated for heating or cooling of the permanent magnet assembly;

a second tubular coil fastened to the shaker housing and coupled to ports on the shaker housing through which a fluid

may be circulated for heating or cooling of the permanent magnet assembly;

the shaker housing being adapted for coupling to a shaker table or an article to be tested.

2. The shaker of claim 1 wherein the first tubular coil and the second tubular coil are coupled in parallel.

3. The shaker of claim 1 wherein the at least one electrically conductive shorting ring is comprised of first and second shorting rings, each being supported on the permanent magnet assembly adjacent a respective one of the wire coils.

4. The shaker of claim 3 wherein the first tubular coil comprises first and second first tubular coil sections connected in series, each coupled to a respective one of the first and second shorting rings.

5. The shaker of claim 4 wherein the first and second first tubular coil sections are formed from a single length of tubing.

6. The shaker of claim 1 wherein the second tubular coil is fastened to the external periphery of the housing adjacent the wire coils.

7. The shaker of claim 1 wherein the permanent magnet assembly is supported within the housing on convoluted epoxy graphite laminate diaphragms.

8. The shaker of claim 1 wherein opposite faces of the shaker housing are adapted for coupling to a shaker table or an article to be tested.

9. The shaker of claim 8 further comprised of an adapter configured to be fastened to one face of the shaker and to be fastenable to a second adapter fastened to an identical shaker.

10. First and second shakers, each in accordance with claim 9, the first and second shakers being fastened together with the axes of the permanent magnet assemblies being coaxial.

11. A shaker comprising:

a sealed shaker housing having a round housing body defining a shaker axis, and first and second end caps;

a permanent magnet assembly supported within the housing for vibratory translation along the shaker axis, the permanent magnet assembly having a cylindrical permanent magnet magnetized in a direction parallel to the shaker axis, and first and second pole pieces spaced apart along the

shaker axis and abutting first and second ends of the permanent magnet;

first and second wire coils spaced adjacent and outward from a periphery of the first and second pole pieces, respectively, and secured to an inner wall of the shaker housing;

the permanent magnet assembly having at least one electrically conductive shorting ring supported on the permanent magnet assembly adjacent at least one of the wire coils;

a first tubular coil fastened to the permanent magnet assembly and flexibly coupled to ports on the shaker housing through which a fluid may be circulated for heating or cooling of the permanent magnet assembly;

a second tubular coil fastened to the shaker housing and coupled to ports on the shaker housing through which a fluid may be circulated for heating or cooling of the permanent magnet assembly;

the shaker housing being adapted for coupling to a shaker table or an article to be tested.

12. The shaker of claim 11 wherein the first tubular coil and the second tubular coil are coupled in parallel.

13. The shaker of claim 11 wherein the at least one electrically conductive shorting ring is comprised of first

and second shorting rings, each being supported on the permanent magnet assembly adjacent a respective one of the wire coils.

14. The shaker of claim 13 wherein the first tubular coil comprises first and second first tubular coil sections connected in series, each coupled to a respective one of the first and second shorting rings.

15. The shaker of claim 14 wherein the first and second first tubular coil sections are formed from a single length of tubing.

16. The shaker of claim 11 wherein the second tubular coil is fastened to the external periphery of the housing adjacent the wire coils.

17. The shaker of claim 11 wherein the permanent magnet assembly is supported within the housing on convoluted epoxy graphite laminate diaphragms.

18. The shaker of claim 11 wherein opposite faces of the end caps are adapted for coupling to a shaker table or an article to be tested.

19. The shaker of claim 18 further comprised of an adapter configured to be fastened to one face of the shaker

housing and to be fastenable to a second adapter fastened to a similar shaker.

20. First and second shakers, each in accordance with claim 19, the first and second shakers being fastened together with the axes of the permanent magnet assemblies being coaxial.

21. A method of vibration testing comprising:

providing one or more shakers having a vibratory permanent magnet assembly within a sealed housing;

fastening the one or more shakers to a first surface of a table;

mounting the table on a compliant mount;

placing an article to be vibration tested on a surface of the table; and

operating the one or more shakers to vibration test the article to be tested.

22. The method of claim 21 further comprising fluid cooling the shakers.

23. The method of claim 21 wherein the article to be vibration tested is fastened to a surface of the table.

24. The method of claim 21 wherein the article to be vibration tested is placed on a second surface of the table opposite the first surface of the table.

25. The method of claim 21 wherein a plurality of shakers is provided and fastened to the first surface of the table.

26. The method of claim 25 wherein the plurality of shakers are distributed in a pattern across the first surface of the table.

27. The method of claim 21 further comprising placing the table with the one or more shakers fastened thereto in a sealed environmental chamber, controlling the pressure in the chamber to differ from atmospheric pressure, and vibration testing the article to be tested at the chamber pressure.

28. The method of claim 26 further comprising changing the temperature in the environmental chamber and vibration testing the article to be tested at the chamber temperature.

29. The method of claim 28 further comprising thermally insulating and fluid cooling the one or more shakers.

30. The method of claim 21 further comprising placing the table with the one or more shakers fastened thereto

inside an environmental chamber, controlling the temperature in the chamber to differ from atmospheric pressure, and vibration testing the article to be tested at the chamber temperature.

31. The method of claim 28 further comprising thermally insulating and fluid cooling the one or more shakers.